FY 2017 Project for Ministry of the Environment, Japan

FY2017
Study of City-to-City Collaboration Project for Low Carbon Society

Study on feasibility of solar power generation system and solar powered low-carbon water treatment system, and promotion of activities in Ayeyarwady Region

Project Report

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List of Abbreviations

This report uses the following standardized units and abbreviations.

Units

t	ton
kg	kilogram
MJ	Megajoule
MW	Megawatt
kW	Kilowatt
kWh	Kilowatt hour
GWh	Gigawatt hour
TWh	Terawatt hour
MPa	Megapascal
ha	Hectare
km	kilometers
m2	Square meter
m3	Cubic meter
t-CO2	Carbon dioxide emissions (t)
kg-CO2	Carbon dioxide emissions (kg)
MMK	Myanmar kyat
USD	U.S. dollar
JPY	Japanese Yen

Abbreviations

ADB	Asian Development Bank
CDM	Clean Development Mechanism
COP	International Conference of the Parties
EIA	Environmental Impact Assessment
EIAP	Environmental Impact Assessment Procedure
EMP	Environmental Management Plan
EPC	engineering, procurement, construction
EPGE	Electric Power Generation Enterprise
ESE	Electricity Supply Enterprise
FY	Fiscal Year
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IEE	Initial Environment Examination
IFC	International Finance Corporation
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contributions
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LDC	Least Developed Country
MALI	Ministry of Agriculture, Livestock and Irrigation
MAPCO	Myanmar Agribusiness Public Corporation
MESC	Mandalay Electricity Supply Corporation
MIC	Myanmar Investment Commission

MIMU	Myanmar Information Management Unit
MRV	Measurement, Reporting and Verification
PV	Photovoltaics
SIDS	Small Island Developing States
SPC	Special Purpose Company
YESC	Yangon Electricity Supply Corporation
UMFCCI	The Republic of the Union of Myanmar Federation of Chambers of Commerce and Industry

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Executive Summary

Study on feasibility of solar power generation system and solar powered low-carbon water treatment system, and promotion of activities in Ayeyarwady Region

Under the city-to-city collaboration through Ayeyarwady Partnership for Low Carbon Initiative, possibility of a PV (photovoltaic) project utilizing JCM scheme, and distributed water treatment system coupled with PV system was explored. Activities for renewable energy promotion and water and environment conservation, such as capacity building and project planning, were supported.

1. Background of the project

Through city to city collaboration under "Partnership for Low-Carbon Initiative (with Ayeyarwady region: starting from in 2015, and with Sagaing Region: starting from Aug. 2017)," JCM (Joint Crediting Mechanism) feasibility of solar power generation system and solar powered low-carbon water treatment system in new industrial parks was studied. The initiative assisted efforts on creation of regional water treatment system (e.g. capacity building, and planning support for facilitating the implementation of projects) in the region.

A partnership was formed between Ayeyarwady Region and Fukushima City as the platform for a new city-to-city collaboration under the collaborative scheme (framework) between the two, and discussions were conducted among stakeholders from both parties. In concrete, the status quo and the needs of Pathein City in Ayeyarwady Region were studied and comprehended, various initiatives by Fukushima City and related technologies were presented as reference, and examinations were performed concerning the possibility of collaboration between both cities, as well as the possibility of deploying the JCM for realization of a low-carbon township in Ayeyarwady Region, in the fields of waste treatment and water treatment, in particular, through joint activities such as the holding of workshops in both Pathein City in Ayeyarwady Region and Fukushima City, mutual visits by members of both cities (including on-site investigations), and exchange of opinions concerning the policy trends of both cities.

- **Ayeyarwady Region, Myanmar**
  Ayeyarwady Region is the largest agricultural area in Myanmar, and the region has been promoting new initiatives in recent years, including the development of new industrial parks (new industrial park in Pathein city, and industrial park in Myaungmya Township etc.), in order to promote the industrialization of the region. This region is considered to be one of the local areas in Myanmar where a rapid economic development is anticipated towards the future, and

accordingly, the experience and knowhow held by Japan that experienced a rapid economic growth in the past are expected to be positively utilized in the region.

- **Fukushima City**
  Fukushima City, while putting the utmost importance on the introduction of renewable energy sources through cooperation among the municipal governments, citizens and business operators, has also been engaged in various initiatives and activities such as “creation of a low-carbon, circular-type society with effective global-warming preventive measures and low burden on the environment”, “restoration from nuclear disaster”, “revitalization of local areas” and “promotion of the building of townships resistant to disasters and emergencies”, aiming at making “Fukushima” a vigorous and environmentally most advanced city, based upon well advanced local production and consumption features, as well as safe and secure energy sources, in the future.

2. Current Situation and Challenges for Low-Carbon Development

Through Partnership for Low Carbon Initiative, importance of developing a sustainable, low-carbon, circular-type, vigorous and environmentally advanced region, and measures for such development (roadmap) have been shared among the participants. With such shared understanding, feasibility of a PV system coupled with low-carbon water treatment system in a new industrial zone within the region has been considered.

Additionally, regarding renewable energy and water conservation, experiences of Fukushima City have been shared (including site visits in Fukushima City), and solar radiance measurement demonstration by Pathein Technological University as part of capacity building has been conducted.

Item	Key activities	Outcome and future tasks
JCM Project Formulation	Examination of candidate sites Examination of installation costs	●There are no experiences in large-scale PV projects and risk is high. ●Possibility for a rooftop solar project at an industrial city needs to be considered first. ●Pros and Cons of following two options are explored <Option 1> Japan side determines all specifications including installation work and

		consign the installation under Japanese company's supervision to local companies. <Option 2> Raise the potential of local companies through the implementation of small-scale installation (several hundred-kW level).
Policy dialogue	Building relations with the responsible minister of energy Through the workshop in the region, common understanding was obtained on the importance of using renewable energy for restructuring of industrial complexes and rice mills.	● Shared understanding for development (i.e., securing of electricity by renewable energy is an effective approach to the development of rice milling business) with not only the chief executive and the responsible minister of the region but other relevant parties including Ministry of Agriculture, Livestock and Irrigation of the Union of Myanmar. ● Hereafter, the region officers intend to conduct policy dialogue to embody the low-carbon society concept in the developing Myaungmya Industrial Zone (The responsible minister of the region is interested in promotion of local electrification using renewable energy. The direction required for such development is shared, and now is the stage to deepen concrete policies).
Business exchange and capacity building	Through the workshop in the region, ● Activities of companies in Fukushima City (MW-scale solar, environmental activities, etc.) were introduced to relevant	● It was understood that not only policy formation but project creation in the business sector has an important role to realize a low-carbon society. ● It was agreed that companies should understand that this is a business opportunity (which is learned through the examples of companies in Fukushima City) ● Dialogue with Chamber of Commerce and companies in Myanmar was a new attempt. They have high expectations for Japanese companies. The parties shared

	business parties. ● Opinions were exchanged on the possibility of cooperation between companies in Myanmar and Fukushima City. ● Importance of dialogue to embody businesses was confirmed and recognition was shared.	the recognition that continued exchange and dialogue is important (e.g. towards realization of cooperation with MAPCO (Myanmar Agribusiness Public Corporation), one of the foremost agriculture-related enterprise in Myanmar. Cooperation with companies in Fukushima is expected.

3. Further Project Development

<Activities for PV system at industrial zones>

- Myanmar is now at a stage of introducing small-scale solar panels, but MW-scale solar plants have not been introduced. The officers invited learned the policies of Fukushima City; visited MW-scale solar power plant promotion facilities and project site; felt and deeply understood the situations of MW-scale solar power generation and facilities; and wish to realize it in their region.
- However, Myanmar does not have experiences with large scale PV projects and high risks remain. Therefore, as a start, smaller scale (200~300 kW rooftop PV on factories) can be installed to accumulate experiences in the field and increase the capacity of local companies.
- Additionally, electricity prices in Myanmar are low; better pricing standards should be explored through policy dialogues with the regional government, from the policy-side aspects of local energy policies and regional development.

<Activities for water treatment and water quality management>

- In Myanmar, although legal systems for environmental regulations have been developed, challenge is how to implement them. The officers from the region deepened their understanding of the mechanism including on-site inspection at municipality level, and sampling/analysis of wastewater (outcome of capacity building specific to intercity cooperation between municipalities).

- Challenge is how to share what the invited officers learned among other relevant parties in the region. It is also important to implement activities in Myanmar based on the activities in Japan.
- Water treatment is an important issue (which is a shared understanding with the regional officials) for rapid economic development; discussions for integrated regional development with industrial zones are essential.

<Capacity building (environmental education)>
- Deeper understanding for importance of environmental education was achieved, and the region now would like to implement such concept in school education. It is expected that efforts in school bring about the awareness-raising of parents (They recognize that awareness of adults on environment preservation is low and awareness-raising is necessary).

<Capacity building (business interactions)>
- In the future, dialogue between businesses, including Fukushima Chamber of Commerce and Industry, member companies, local Chamber of Commerce and Industry and members would be necessary for possibility of collaboration on specific projects.

<Low-carbonization of industrial zones>
~Possibility for Low-Carbon Urban Development Model as Agricultural Industrial Zone and Agricultural Industrial City~
- Construction of Myaungmya Industrial Zone (agriculture and food related industrial zone) is in progress with support from the government (regional and union level). Rice husk power plant project of 1.6 MW is in progress as well with JCM subsidy, and receives high expectations from the government (the responsible minister is satisfied as well).
- Through policy dialogues, it was identified that the counterpart ministers are those responsible for electricity, energy, industry and transport. They have high interest for low-carbon, environmentally friendly industrial zone development (including its surrounding areas) from multiple aspects of energy access (renewable energy, distributed energy resources), environmental conservation, and local industry promotion. In the future, specific measures would need to be planned under city-to-city collaboration.

1. Purpose and Implementation Arrangement

1.1 Project Objective

All countries attended the 21st International Conference of the Parties (COP21) on the United Nations Framework Convention on Climate Change held in December 2015 in Paris, France. They adopted the Paris Agreement, a legal framework of equitable and effective measures against climate change from 2020 onward. The Paris Agreement demands the promotion of activities toward decarbonization, stating that the temperature rise of the earth should be less than 2 degrees C adequately compared to the preindustrial era and efforts should be made to decrease it down to less than 1.5 degrees C. COP21 also decided that the activities of non-state entities including cities must be grasped, and that the efforts of all nongovernmental entities (cities and other local public bodies) are appreciated and their scale-up must be promoted.
“Marrakech Action Proclamation for Our Climate and Sustainable Development” adopted in COP22 held in November 2016 in Marrakech, Morocco, emphasized again that the global climate was warming at an unprecedented rate and we were obliged to take urgent countermeasures. It was recognized that global actions of not only national governments but also municipalities, as well as economic turnabout, would give a positive opportunity to further prosperity and sustainable development.
A city is the place of activities that support the development of society and economy. Many people live there. About 50% of the world population live in cities, the area of which is less than 2% of that of all lands in the world. The ratio is anticipated to increase up to 70% by 2050. As it is estimated that more than 70% of CO2 emissions in the world were from cities in 2006, the role that cities play in mitigating climate change is great. For achieving the goal of Paris Agreement, it is important to implement measures against climate change steadily in urban areas to reduce emissions of greenhouse gas.
In this project, Japanese research institutes, private companies and universities as well as Japanese municipalities having experience regarding the formation of a low-carbon society supported such formation by the cities of developing countries based on intercity cooperation. To promote the formation, capacity building in the cities of developing countries was also propelled with the support of Japanese municipalities.

1.2 Survey Items

Based on the aforementioned background and objective, this research surveyed the following items for a solar power generation with low-carbon water treatment system, to be installed in a new industrial zone under construction in Ayeyarwady Region, Myanmar.

(1) Overview of the area and local needs
(2) JCM Project Feasibility
(3) Low-carbon society development support
(4) Participation in local surveys, workshops and other meetings

1.3 Survey Arrangement

The research was conducted by Mitsubishi Research Institute (MRI) as the representative, cooperating with Fujita, its research partner, Fukushima City, and Fukushima Chamber of Commerce and Industry Companies. The research was conducted in coordination with local companies and with cooperation from Ayeyarwady Region.

<Roles of Entities from Japan>

- Mitsubishi Research Institute, with its rich experiences in policy implementation, planning, and JCM research for the Japanese national and municipal government, collected relevant information, managed workshops, considered measures for forming JCM projects, and supported policy dialogue between Fukushima City and the local government (Ayeyarwady Region), in addition to its role of the overall project management.
- Fujita Corporation, with its knowledge and experiences in industrial, urban, and regional development, considered possibilities for specific project formulation (solar project, low-carbon water treatment with solar power).
- Fukushima City had policy dialogue with the officials of the local government to discuss policy-side approach for low-carbon, environmentally friendly regional development, introducing its experiences in establishing renewable promotion plans (e.g. solar power), environmental measures (e.g. measures for effluent), and raising environmental consciousness (e.g. educational programs at school). Department of environment served as the main counterpart from Fukushima City.
- Fukushima Chamber of Commerce and Industry Companies cooperated with its member companies to introduce their technologies and know-how in businesses, and to investigate possibilities in transferring technologies of companies from Fukushima City.

<Roles of Entities from Myanmar >

- MAPCO (Myanmar Agribusiness Public Corporation) served as the local partner company. It cooperated with Ayeyarwady Development (developer of a new industrial city in Pathein City) in the project.
- Various stakeholders from the Ayeyarwady Regional government contributed, including the Minister of Ayeyarwady Region (in charge of electricity, energy, industry, and transportation) as the head, and other officials from the Department of Industry, Environment, Investment and Urban Development.

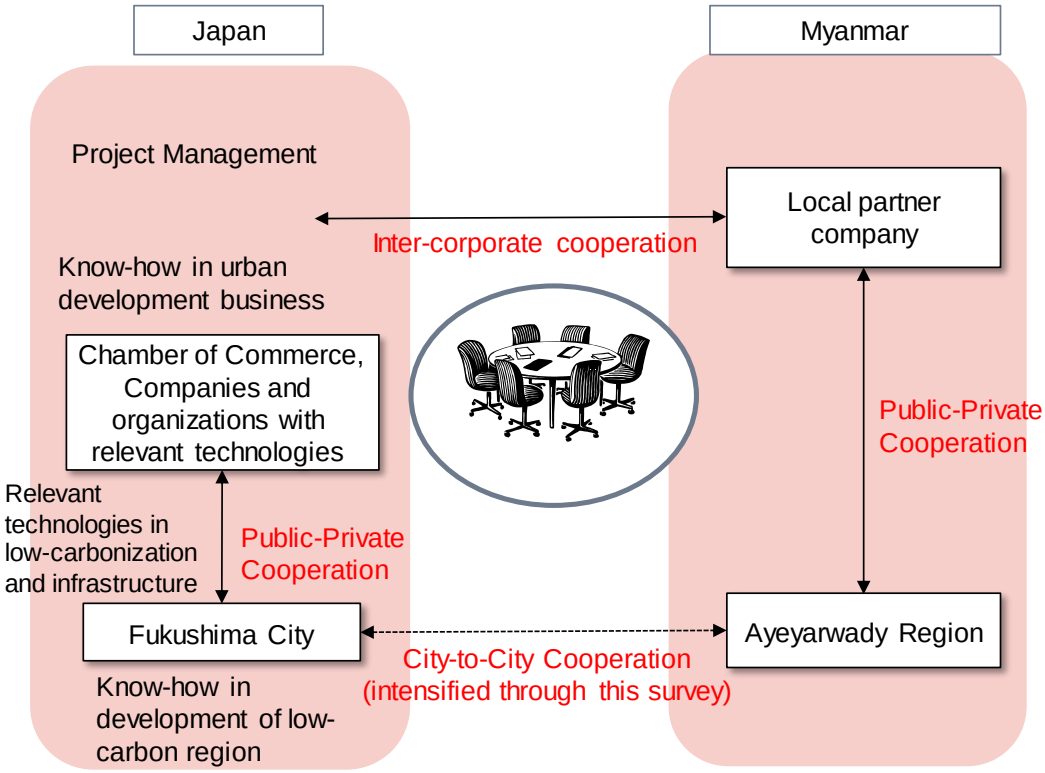

Figure 1-1 Organizational Structure

1.4 Overview of City-to-City Cooperation

Ayeyarwady Region, which is the main product districts of rice, is concerned with work of clearing off large amounts of rice husks (in rice cropping districts, the largest amount of waste is rice husks).
As economy grows, how to address power shortages and emerging environment problems (waste, water preservation, etc.) became the most important issue in local cities in Myanmar.
Establishment of low-carbon, environmentally-friendly industrial zone is expected by applying the experiences of Japanese municipalities and companies. Additionally, such unique regional development is important for attracting businesses and promoting the industrial sector.
Myanmar has high expectations for Japanese experiences and technologies which have undergone rapid economic growth in the past. When the Chief Minister of Ayeyarwady Region visited Japan towards the end of April 2015, he learned about the activities related to energy efficiency and renewable energy in Fukushima City. Then, in June of the same year, the Chief Minister sent an official letter of intent to the Mayor of Fukushima City asking for support and cooperation in the development of Pathein Industrial City (letter asking for support and cooperation for the creation of a sustainable low-carbon city under an inter-city cooperation scheme).
In response to such a request for support and cooperation, Fukushima City, the Fukushima Chamber of Commerce and Industry, Mitsubishi Research Institute, and Fujita Corporation jointly established a partnership called the “Partnership for a Low-Carbon Initiative in Ayeyarwady” as a platform for inter-city cooperation, and decided to perform activities for the city-to-city cooperation. In FY 2015, the Partnership held workshops in Pathein City in Ayeyarwady Region as well as in Fukushima City, conducted field surveys and made policy dialogues, and examined the possibilities of developing a project applicable to the subsidies under JCM Scheme. And furthermore in February 2016, when government officials of Fukushima City visited the site in Ayeyarwady Region, they handed the Minister in charge of the Region a letter from the Mayor of Fukushima City responding to the request for support and cooperation, and expressed Fukushima City’s willingness to cooperate with Ayeyarwady Region not only in the sectors of renewable energy and waste treatment but also in various important matters such as the formulation of a master plan, based on Fukushima City’s experience hitherto so as to achieve a sustainable, resilient, and low-carbon society in Pathein City.

<Past Activities>

June 2015	Chief Executive of Ayeyarwady Region made a request to Mayor of Fukushima City for cooperation.
October 2015	Relevant parties of Ayeyarwady Region visited Fukushima City.
February 2016	Relevant parties of Fukushima City (Deputy Director of Environment Division, etc.) visited Ayeyarwady and hand over a reply letter of Mayor of Fukushima City regarding the request

	to the responsible Minister of Ayeyarwady Region.
September 2016	Workshop in Ayeyarwady (attendance of Chief Executive of the region)
October 2016	Director of Urban Development Bureau of Ayeyarwady Region, etc., visited Fukushima City.
January 2017	Discussion on the direction of project expansion at WS in Ayeyarwady (attendee: responsible Minister of Ayeyarwady Region, Chief of Environment Section of Fukushima City, etc.)

Based on such activities, under the city-to-city cooperation and the Ayeyarwady Partnership for Low-Carbon Initiative, activities for project formulation (e.g. JCM) using PV system in new industrial zones, PV system coupled with distributed water treatment system, capacity building, and business planning were supported.

<Activities conducted this year>

July 2017	Secretary General of Investment Committee of Ayeyarwady Region, etc., visited Fukushima City.
	Responsible Minister of Ayeyarwady Region made a request to Mayor of Fukushima City for cooperation for development under collaboration of Sagaing and Ayeyarwady Regions.
September 2017	Workshop in Ayeyarwady (attendance of responsible Minister of the region)
February 2018	Workshop in Ayeyarwady

Part of the activities under city-to-city cooperation through the partnership for low-carbon initiative are conducted in cooperation with FY2017 Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration (“Study on feasibility of solar power generation system and solar powered low-carbon water treatment system, and promotion of activities in Ayeyarwady Region” and FY2017 Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration (“Study on feasibility of a low-carbon waste treatment system and micro-grid system and promotion of activities under inter-regional collaboration in Ayeyarwady region and Sagaing region”).

- Outline of workshop and site visits in Fukushima City
  On July 24 (Mon) to 26 (Wed), two officers of Ayeyarwady Region were invited to Fukushima City. Courtesy call to Mayor and Chairperson of the municipal assembly; site visits in Fukushima City; and a workshop were held. Measures to diffuse PV systems in Fukushima City and regulatory activities for water preservation (in particular, on-site investigation by administrative agencies, which was a measure that relevant parties of Ayeyarwady were interested in) were introduced. Activities of environment education in schools (elementary schools) were also introduced; school teachers participated and explained some educational programs, and a video letter from elementary school students was shared. These were explained at the workshop and during site visits. Participants from Ayeyarwady commented that these were very informative for

future activities in Ayeyarwady.

An exchange meeting with member companies of Chamber of Commerce was held. A participant from Myanmar introduced the institutional trend of the Investment Law. Exchange of opinions was made regarding the possibility of further participation of Fukushima’s companies.

2. Overview and Needs of the Area

2.1 Overview of the Area and Local Policies

In this section, the socio-economic situation of the Ayeyarwady Region is described.

2.1.1 Socio-Economic Situation of the Area

According to the Myanmar Information Management Unit (MIMU), Ayeyarwady Region is the most populated region in Myanmar, with population of approximately six million and area of 35,964 square kilometers. There are six districts and 26 townships in the region. Of all the regions in Myanmar, Ayeyarwady Region has the highest percentage of people living in rural area (88%). Ayeyarwady Region has been one of the most developed area in fisheries and agriculture.
New work is underway for industrialization in Ayeyarwady Region as well. There are numerous plans for industrial zone construction by foreign investors and local companies. Plan for constructing a port along the western coastlines of the region is underway; it was recently announced that 11 billion USD investment would be put into the 514 km coastline development project, constructing not only port but also special economic zones and road infrastructure[1]. In this way, infrastructure for industrialization is being developed in Ayeyarwady Region, and it may become one of the economic centers of Myanmar in the future.

[1] "Pristine Ayeyarwady coastline flagged for new $10bn industrial zone" Frontier Myanmar (accessed: February 26, 2018) https://frontiermyanmar.net/en/pristine-ayeyarwady-coastline-flagged-for-new-10bn-industrial-zone

Figure 2-1 Ayeyarwady Region, Myanmar

Source) Myanmar Information Management Unit

2.1.2 Power Sector Situation

(1) Main Policies for the Power Sectors

There are three main policies related to the electricity sector in Myanmar: Myanmar Energy Master Plan, National Electricity Master Plan, and National Electrification Plan.

Myanmar Energy Master Plan was formulated under the support of ADB (Asian Development Bank). It analyzed the effective use and the optimum energy composition of various primary energy resources toward 2030. A trial calculation of energy demand by sector (residential, commercial, industrial and agricultural) was made in the plan.

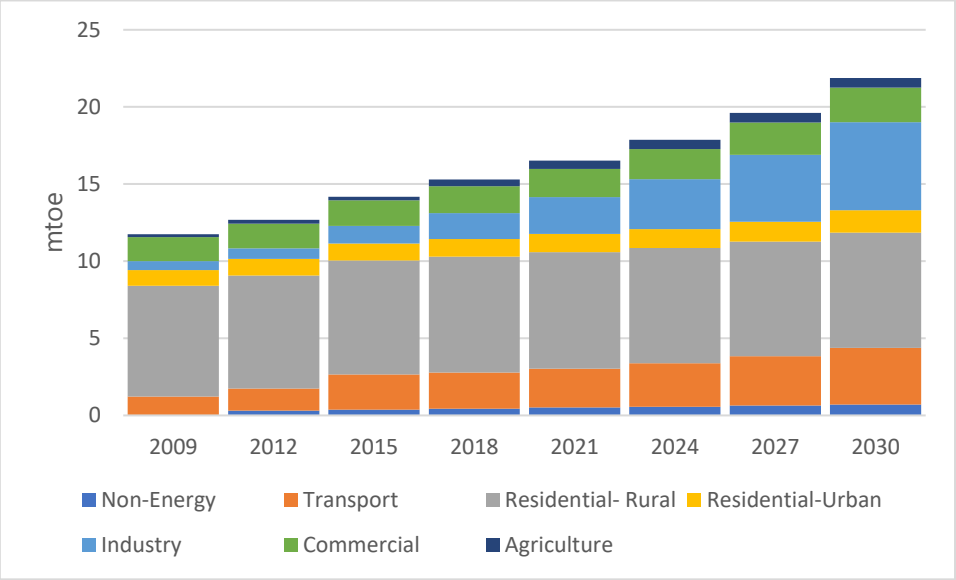

Figure 2-2 Energy Demand by Sector in 2030 (middle scenario, mtoe)

Source) Myanmar National Energy Master Plan

As known from the above prospect, significant increase in energy demand following economic development is anticipated. In particular, increase in the industrial sector is large. Final energy consumption by energy carrier is shown below.

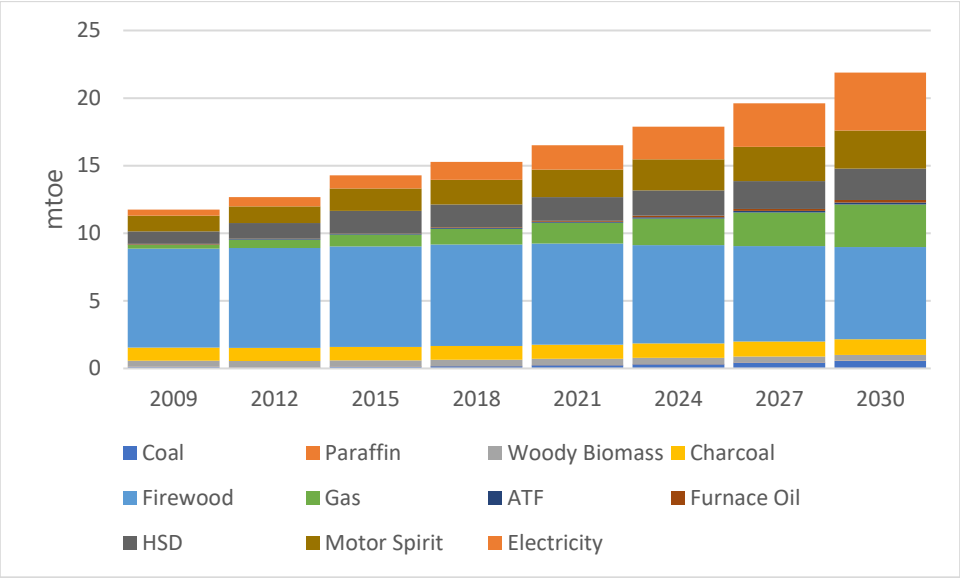

Figure 2-3 Final Energy Consumption by Energy Carrier (middle scenario, mtoe)

Source) Myanmar National Energy Master Plan

Electricity demand is shown in orange at the top of the bar chart. It is seen that increase of the demand toward 2030 is larger compared to other energy carriers. National Electricity Master Plan was formulated under the support of JICA (Japan International Cooperation Agency). It examined the prospect of electricity supply and the ideal energy composition toward 2030. Power source composition toward 2030 is shown below.

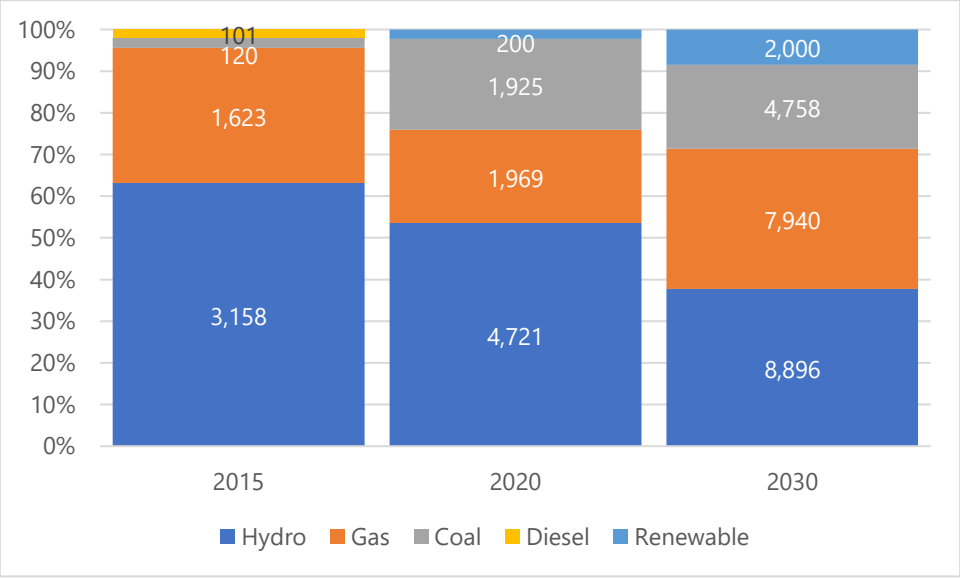

Figure 2-4 Installed Capacity for 2030 (GW)

Source) Myanmar National Electricity Master Plan

Myanmar is rich in water resources. In 2015, hydropower generation occupied more than 60% of the nation's installed capacity, while gas-fired power occupied a little over 30%, coal-fired power and diesel power being the remainder. A problem of this power source composition is the difference in the production of electricity between rainy

season and dry season. A policy of decreasing the dependence on hydropower was expressed in the prospect toward 2030. Anticipated power source composition in 2030 is: hydropower 8,896 MW (38%), coal-fired power 7,940 MW (33%), gas-fired power 4,758 MW (20%), and others including renewable energy 2,000 MW (9%).
The supply and demand projection of electricity and master plans were established in Myanmar. However, its average electrification rate is thirty odd percent, the rate being lower in some regions. Based on this situation, Myanmar Government, setting the goal of achieving 100% electrification rate in 2030, showed a roadmap in National Electrification Plan formulated under the support of World Bank.
The plan assumed that 99% of the households were electrified by power transmission from the central grid while the regions located at the fringe of the grid were electrified by off-grid (use of mini-grid and household-use photovoltaic power generation) to promote electrification more rapidly. The responsible ministry of realizing the electricity supply from the central grid is Ministry of Electricity and Energy, while the one of realizing the mini-grid projects is Ministry of Agriculture, Livestock and Irrigation. Overseas organizations (World Bank, ADB, GIZ of Germany) are now providing technical support on mini-grid, the specification and level being formulated.
Minigrid projects funded by ADB (80% of project cost covered) are shown below. Vendors must own the responsibility of maintenance and management for three years, and renew battery system installed with the system after three years.

Table 2-1 Mini-Grid Projects with ADB Support

Township	Households	Population	PV Capacity	Battery kWh	Cost Total USD	Type
Magway Region						
Thayet	197	931	7.2	57.6	73,350	Stand-alone
Sinbaungwe	270	2,170	8.7	63.3	82,368	Stand-alone
Minbu	89	336	4.9	57.6	44,100	Diesel hybrid
Yenangyaung	330	1,654	130	92.2	102,300	Stand-alone
Salin	143	625	6.5	38.4	50.832	Stand-alone
Pauk	157	836	6.0	46.1	50.856	Stand-alone
Mandalay Region						
Kyaukse	317	925	10.8	86.4	98,580	Grid ready
Nyaung-U	200	977	9.8	115.2	75,000	Stand-alone
Kyaukpadaung	103	484	4.9	57.6	87,980	Stand-

						alone
Taungtha	110	654	4.9	57.6		Stand-alone
Sagaing Region						
Sagaing	170	569	6.0	46.1	102,770	Stand-alone
Khin-U	165	668	7.0	61.4		Stand-alone

Source) ADB “Developing Renewable Energy Mini-Grids in Myanmar: A Guidebook”

Note) “Stand-alone” refers to an off-grid system, “Diesel hybrid” refers to a hybrid system of diesel and solar, “Grid Ready” refers to a system that can be connected to the grid

(2) Financial Situation of the Power Sector

As described above, considerable new investments in facilities are anticipated in the electricity sector in Myanmar hereafter. From a financial point of view, however, serious deficit situations continue in the electricity sector in Myanmar. Power generation projects in Myanmar are implemented by private power generation enterprises and publicly-owned Electric Power Generation Enterprise (EPGE). First, energy produced is bought by EPGE temporarily (if supplied to the grid), and then bought by transmission and distribution enterprises (Electric Supply Enterprise (ESE), Yangon Electricity Supply Corporation (YESC), or Mandalay Electricity Supply Corporation (MESC) depending on regions) and supplied to consumers. Electricity charges are determined based on the living standards of consumers for improved electricity access (see the table below). However, as this is not the level of electricity charges sufficient to recover the costs of power generation, procurement, transmission and distribution, the electricity sector in Myanmar is in serious deficit situations (anticipated deficit in fiscal 2017 is about 37.7 billion kyat). The government subsidizes the operation (anticipated to be Ks.22.66/unit in fiscal 2017) to cover the deficit. The subsidy is as much as the value that occupies a little under 10% of the budget of Ministry of Electricity and Energy.

Table 2-2 Electricity Tariff in Myanmar

Residential		Industrial	
~100 kWh	35 Kyat/kWh (USD 0.03)	~500 kWh	75 Kyat/kWh (USD 0.06)
101~200 kWh	40 Kyat/kWh (USD 0.03)	501~10,000 kWh	100 Kyat/kWh (USD 0.07)
200 kWh~	50 Kyat/kWh (USD 0.04)	10,001~50,000	125 Kyat/kWh (USD 0.09)
		50,001~300,000 kWh	150 Kyat/kWh (USD 0.11)
		300,001~ kWh	100 Kyat/kWh (USD 0.07)

Source) Lincoln Legal Services (Myanmar) "Legal and Tax Considerations when Investing in Myanmar's Renewable Energy Sector with a Focus on Electricity Tariffs"

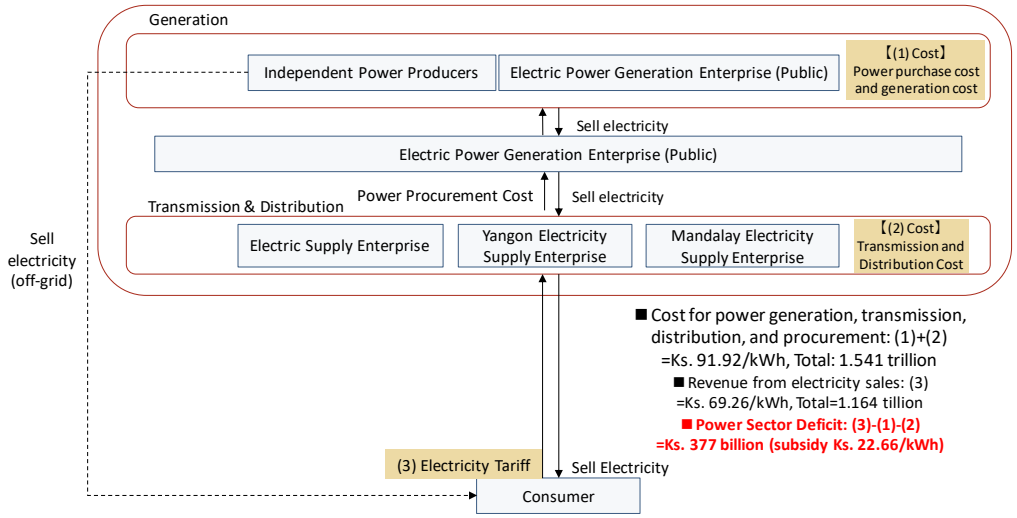

Figure 2-5 Actors Involved in Power Supply in Myanmar

Source) Lincoln Legal Services (Myanmar) "Legal and Tax Considerations when Investing in Myanmar's Renewable Energy Sector with a Focus on Electricity Tariffs"

(3) Renewable Energy Policies

The reasons Myanmar government considers introducing renewable energy as power generation facilities are environmental consideration and its role as distributed power sources for electrification (short lead time and usefulness in off-grid). As described above, Electricity Master Plan assumes that renewable energy other than hydropower occupies 9% of the installed capacity in 2030 and it will be covered by various resources such as photovoltaic power, wind power and biomass power generation. Solar power is one of the renewable energy resources that is particularly gaining attention in Myanmar. Solar radiationin Myanmar on average is approximately 4.5 ~ 5.1 kWh/m2; solar power potential is high. Solar power projects have short lead time, which makes them suitable for minigrid projects. They are installed in modules, which enables size increase in later phases. Compared with large scale power plants, solar power plants utilize relatively simple technologies requiring simple maintenance work

as well. However, as they can only generate when the sun shines, utilization of batteries is indispensable. Using batteries for covering solar generation requires deeper charge and discharge rate, which may accelerate their degradation and increase project cost. Average generation data of a solar power plant in Myanmar is shown below.

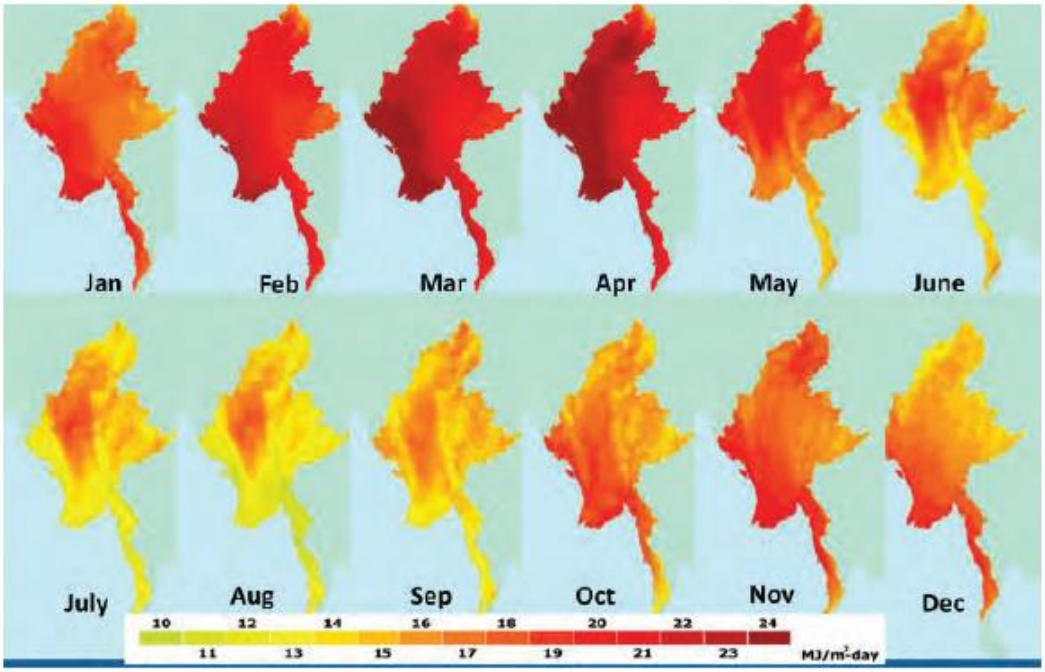

Figure 2-6 Average Solar Power Generation by Month

Source) ADB “Developing Renewable Energy Mini-Grids in Myanmar: A Guidebook”

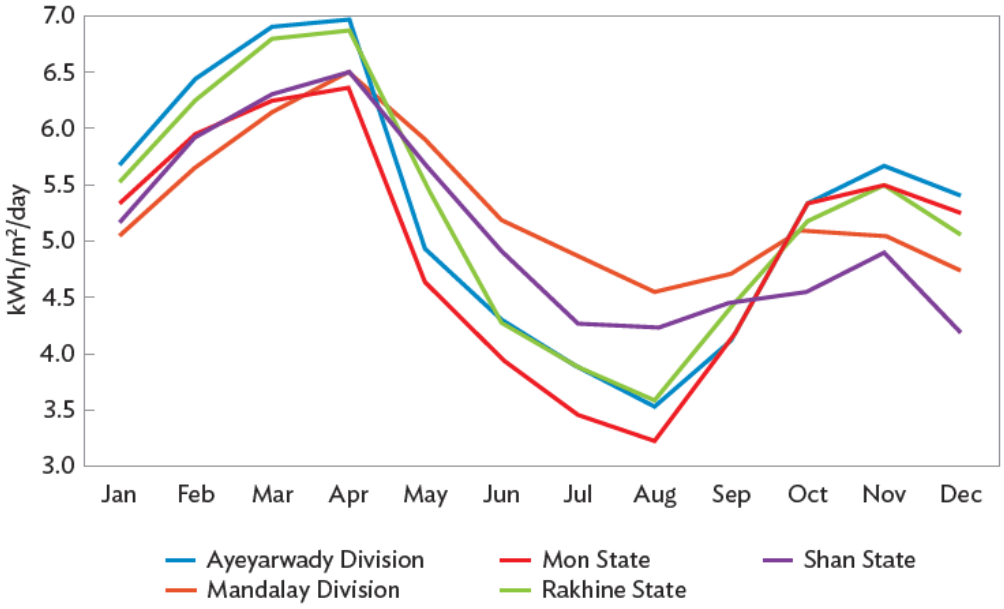

Figure 2-7 Average Solar Power Generation by Region

Source) ADB “Developing Renewable Energy Mini-Grids in Myanmar: A Guidebook”

On the other hand, hydropower is an attractive resource in Myanmar with rich water resources. The country possesses experiences in hydropower projects. However, challenges remain in their lead time (necessary time period for construction) and unstable generation between rainy and dry seasons, impacting stable power supply. Biomass resources, such as waste generated from agriculture (e.g. rice production) in Myanmar can also be utilized for power generation. Such concept is promising as there are abundant biomass resources in Myanmar; however, challenges remain in stable procurement of such biomass resources.

However, a big issue regarding renewable energy is the setting of power selling price. Currently, it is difficult for renewable energy projects to be economically recoverable under the average power price in Myanmar. When a power generation project is implemented, energy produced must be sold to publicly-owned EPGE unless it is an off-grid project. However, renewable energy projects can be hardly realized with the same level of power selling price as other power generation such as coal-fired.

Although the introduction of a fixed-price purchasing system was discussed referring to the examples of other countries, the government is discreet about its introduction currently because deficit situations continue in the electricity sector. Although the raise of electricity charges for consumers was discussed several times (the last one is in 2013), it was strongly resisted by citizens and has not been realized. However, the necessity of raising electricity charges comes to be understood year by year widely, and the necessity of reviewing the charge setting is pointed out by not only Myanmar Government but also international organizations including IMF. In May 2017, it was announced again by Ministry of Electricity and Energy to review the level of electricity charges.

In order to introduce renewable energy sufficiently in Myanmar, it is necessary to discuss it in combination with the policies of how renewable energy should be positioned in the entire power source plan and how power supply should be subsidized by the government. Specifically, it is necessary to consider the extent to which distributed power sources are introduced for promoting cost-effective electrification in Myanmar, the extent to which subsidy is needed, and whether or not the subsidy can be put out from the electricity charge subsidy which is applied currently to the retail electricity charges across the board

In Myanmar, renewable energy is promoted from various social aspects, including reinforcement of power supply, electrification, environmental considerations, and industrial development. Establishing a renewable energy policy requires collaboration between related ministries; currently, energy policies are promoted by the Ministry of Electricity and Energy, renewable energy working group is established by the Ministry of Education, energy conservation policies are being considered by the Ministry of Industry, and off-grid electrification plans are being managed by the Ministry of Agriculture, Livestock and Irrigation. Activities involving renewable energy are being conducted in various ministries, and a comprehensive policy for renewable energy promotion is indispensable.

In off-grid areas, many photovoltaic panels of a scale meeting the demand of air-conditioners and lights of several households were introduced as very small-scale grids using the government subsidy for electrification. In addition, projects for the PV power

connected to the main grid came to be implemented in Myanmar in the past several years. Sunlabob Renewable Energy in Laos concluded contracts of 100 kW scale grid-connected PV projects at two sites in Myanmar. The company concluded contracts with developers and factories at each site of the projects and provided benefits such as reductions in grid energy consumption and fuel costs of diesel generators. Shwe Taung Group concluded a contract in 2016, which is a company operating Junction City, composite-type commercial facilities at the central part of Yangon, where a 117 kW PV system is planned to be introduced. A 92.6kW PV system was introduced on the roof of a sewing factory in 2017, providing benefits such as reductions in grid energy consumption and fuel costs of diesel generators like the project mentioned above. The price level of power selling to the grid does not seem to be high. However, it is presumed that industry and commercial consumers, the electricity charge level of which is higher than households and which will become the main target of the raise of the charge in the future, have in particular an advantage of minimizing the risk concerning running costs owing to reduction in grid power consumption.

2.2 Local Needs

The following needs were expressed by the local regional officers through workshops:

- In Myanmar, there were no international relations in the former regime, but the current regime has made some changes, and more foreign investment will be accelerated. Government to government investment and private investment are both within the scope. The past projects conducted by the government are to be transferred to the private sector. The government is only involved in the textile sector which cannot be transferred to the private sector yet. The government is well aware that activities in the industrial sector are lagging. They would like to proceed with new activities with support from various stakeholders.
- The capital of Ayeyarwady Region is Pathein City with population of 0.3 million and 24 states. 20% of power is supplied from the grid in Ayeyarwady Region. The largest challenge in the region is power supply, which is critical for industrialization. 30% of population is placed in the urban area, and the rest in the rural area. Power is supplied from the grid in the urban area, whereas in rural areas the power supply is weak. Even in the urban areas, power is available during the day, but not very reliable during the night. In the future, development of the rural area must be taken into consideration as well. There are some guidance for development plans for the rural region. Power supply is particularly important.
- The new government regime recognizes power supply as a serious issue. Therefore, there will be governmental support for investment in the generation sector. Electricity from the grid is expensive, about 35 MMK to 100 MMK. Electricity cost has been considered as an issue by the government, and more reliance on cheaper sources will most likely be considered. Renewable energy is attractive but its cost is expensive; measures for reducing their cost is important as well.

3. JCM Project Feasibility Study

3.1 JCM Project Formulation

3.1.1 Project Overview

Possible JCM project for PV system in new industrial zone (Myaungmya district), its location and technology is considered.
Possible JCM project for PV system coupled with small-scale distributed water treatment, which has high needs within the area, is considered. Water treatment facilities utilizing septic tanks of foreign manufacturers have been installed in Myanmar in the past, but it has been difficult to maintain those facilities due to lack of guidance and engineers for their operations. Myanmar is not accustomed to spending a large portion or project cost on maintenance and operation, which has resulted in a product sales model without sufficient maintenance services.
Septic tanks, compared with general sewerage system, requires less investment cost and shorter installment period. On the other hand, septic tanks are planned and installed assuming that an appropriate operation and maintenance are in place. Therefore, when operators of the septic tanks lack necessary operation and maintenance works, the functions of septic tanks are not carried out.
The proposed project location is an industrial zone, which is capable of providing resources and services for operation and maintenance. The project would be effective by serving as a regional model for septic tank installment.

3.1.2 Project Site

The following two sites at new industrial zones in Ayeyarwady Region are compared as possible project locations: Pathein Industrial City and Myaungmya Industrial Zone.

(1) Pathein Industrial City

Pathein Industrial City has an area of approximately 1,000 ha and is being developed by Ayeyarwady Development, related to the project's local counterpart. Placing industrial zone at the center, relevant infrastructure including residential housings, large commercial facilities, hotels, leisure facilities, and water treatment facilities are to be developed around the industrial zone in an integrated manner.
According to the conceptual master plan, the project development zones are as follows:

- Zone A (2016-2019): Development work to be done on 1,200 acres of industrial zone
  - Zone A-1 (607.33 acres): Salable area (460.41 acres) and utility & green space (146.92 acres)
  - Zone A-2 (553.48 acres): Salable area (390.83 acres) and utility & green space (162.65 acres)
- Zone B (2019~): Development work will be done on 1,500 acres of industrial and

commercial zones

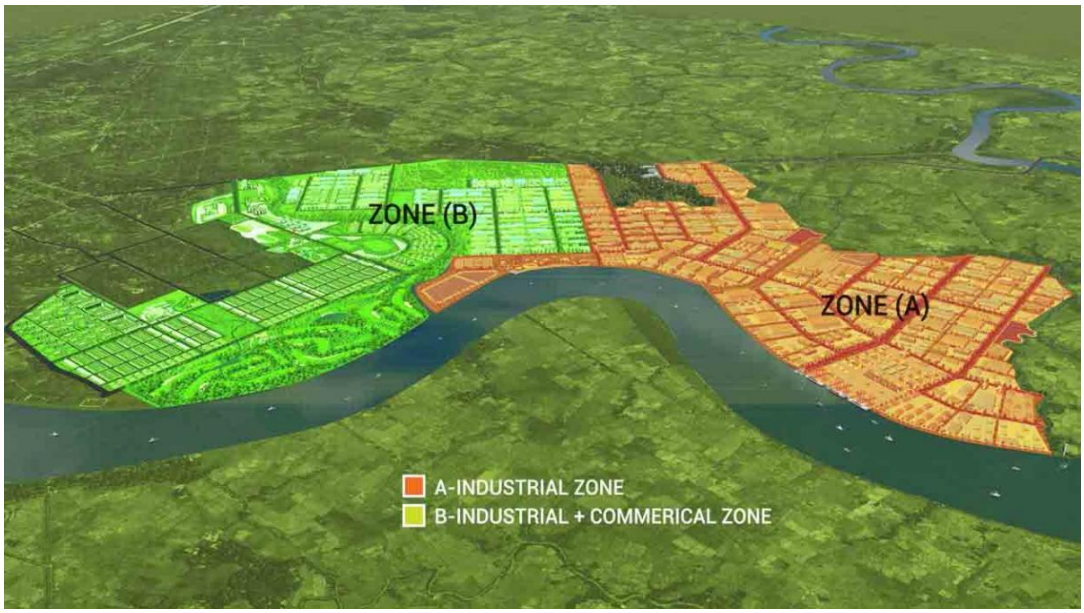

Figure 3-1 Zone Conceptual Plan of Pathein Industrial City

Source) Pathein Industrial City Project Website http://www.picmyanmar.com/conceptual-master-plan (accessed February 18, 2018)

Figure 3-2 Pathein Industrial City Project Overview

Source) Pathein Industrial City Project Website http://www.picmyanmar.com/conceptual-master-plan (accessed February 18, 2018)

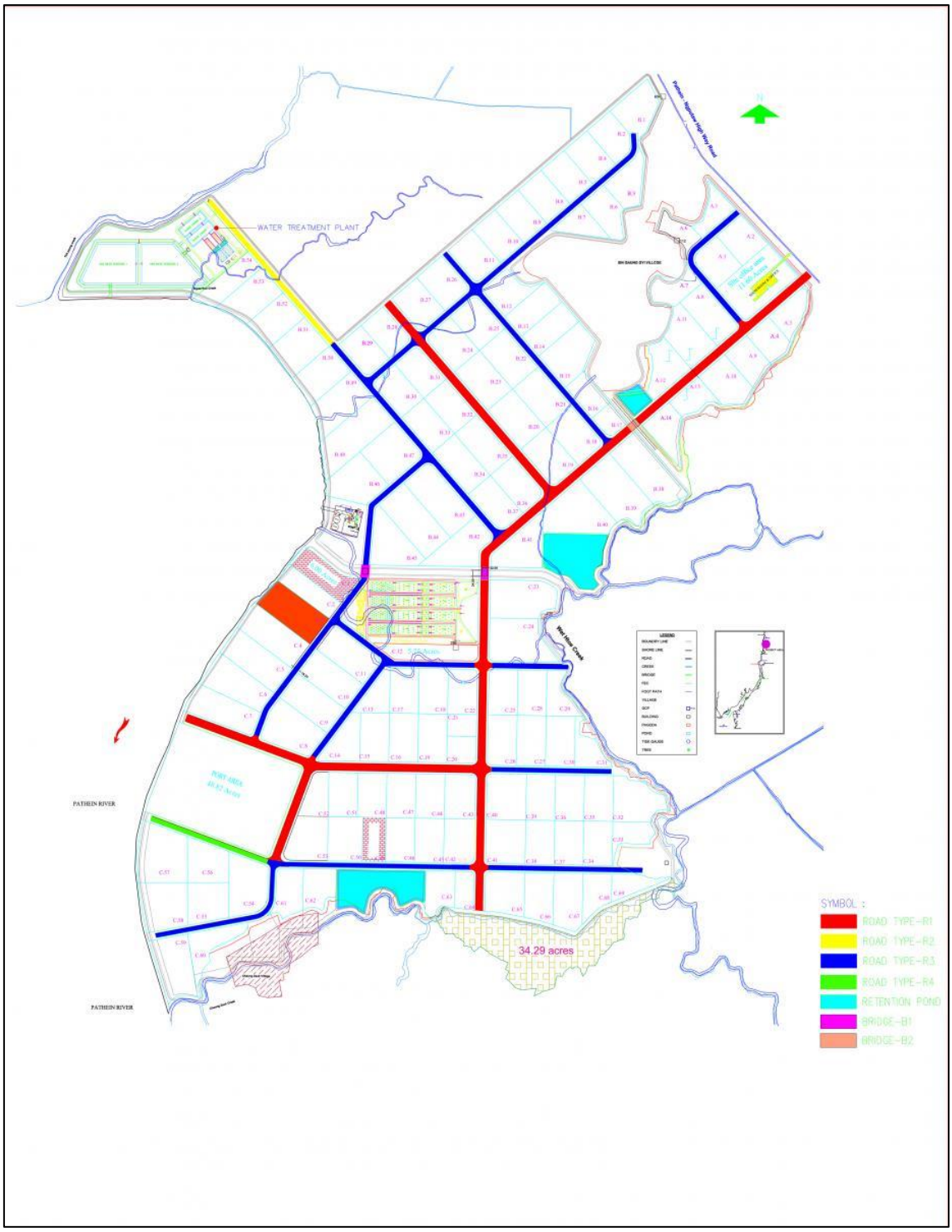

Figure 3-3 Zone A: Industrial Development in Master Plan

Source) Pathein Industrial City Project Website http://www.picmyanmar.com/conceptual-master-plan (accessed February 18, 2018)

However, there has been some delay in incoming tenants for the industrial zone due to various reasons: competing industrial zones are also being developed in other areas of Myanmar (e.g. Thilawa), road infrastructure for providing access from Yangon to Pathein is delayed, etc. As a result, there have been some delays in development plan of Pathein Industrial City.

(2) Myaungmya Industrial Zone

Myaungmya is a city in Ayeyarwady Region in the southern area of Myanmar. Located about 150 km west of Yangon. One hour by car toward southeast from Pathein, the capital of Ayeyarwady. It has a port for accumulation and shipping of rice. MAPCO (Myanmar Agribusiness Public Corporation) is the owner of the land of Myaungmya Industrial Zone. The zone is under construction with the purpose of promotion and development in the agricultural sector mainly. Main tenants assumed are agriculture/food related enterprises such as rice milling and feed production enterprises. The plan of 1.6 MW rice husk power generation facilities is in progress according to the JCM scheme. There is a vacant lot previously used as football ground (2,500 m^2). It can be considered as the site for PV installation.

For the development of this industrial zone, MAPCO filed an application with MIC in 2014. However, because regime change and law reform after it occurred, and there is no registration in the contract between MAPCO and MALI (Ministry of Agriculture, Livestock and Irrigation) (registration is not required in a contract with the government), these practices were a little confusing and took time, but finally “No Objection Letter” was obtained from MALI. As MAPCO had already finished various preparations, just waiting the permission of MIC, the development is expected to progress rapidly.

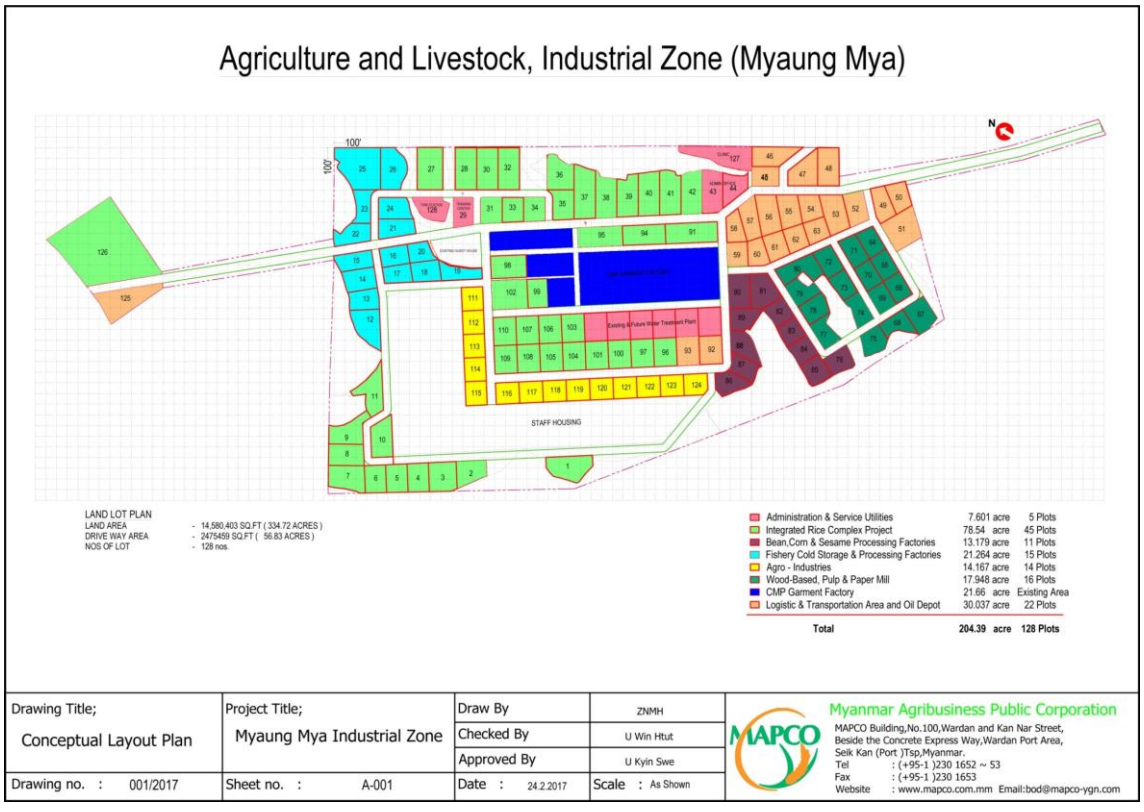

Figure 3-4 Overview of Myaungmya Industrial Zone

Source) Resources provided by MAPCO

Figure 3-5 Images of Myaungmya Industrial Zone

Source) Resources provided by MAPCO

For Myaungmya Industrial Zone, however, because the new government adopted a policy of returning (leasing) the land back to farmers, the possibility became high of the PV project not being included in the scope of permission (agriculture-related businesses) for sublease of the land.
Therefore, it has been decided to further assess the project feasibility study of JCM project with an assumption that the project site will be Myaungmya Industrial Zone.

3.1.3 Applied Technology

Based on some assessments, roof-top PV system on top of a factory is considered the most feasible.

(1) PV System Installment

For a 1 MW PV system, necessary area would be 10,000 m2.

Table 3-1 Overview of the PV System

Power	1,000	kW
Average Irradiance	19	MJ/m2/day
	5	kWh/m2/day
Average annual irradiance	1,928	kWh/m2*year
Irradiation intensity	1	kW/m2
Load factor	0.8	
Annual generation	1,542,344	kWh/year
Daily generation	4,226	kWh/day
Necessary area	10	m2/kW
	10,000	m2

(2) Installment Cost

Without the base part , the total cost is roughly estimated at 0.26 billion JPY. The cost

components are shown below.

Table 3-2 1 MW PV System Cost Estimate (million JPY)

	Estimate
Panel	120
Inverter	33
Installment	69
Others	42
Total	264

3.1.4 Other Socio-Economic Impacts

Direct and indirect socio-economic impacts, asides GHG emission reduction effects, are described below.

(1) Economic Impact

- Industry Promotion Effects
  For economic development in Ayeyarwady Region, electricity required for construction of industrial zones and development of infrastructure must be supplied at an appropriate timing. As Ayeyarwady Region is located at the fringe of the national grid, securing electricity from the grid is limited. For the development of new industrial zones, significant effects are expected in establishing an independent distributed power supply system using photovoltaic power generation.

(2) Social Effects

- Effects of promoting electrification in local communities around an industrial zone
  Myanmar government considers the increase of electrification rates as an important policy. To improve the quality of life, electrification is indispensable especially in rural districts where current electrification rates are low. Stable power supply is also indispensable in the fields such as treatment of domestic wastewater, which are essential for environmental preservation in rural districts.
  Myaungmya Industrial Zone, a promising candidate site, is an agriculture-related industrial complex including rice mills and rice processing facilities, located in a rural district.
  It is therefore expected that this photovoltaic power generation project in Myaungmya Industrial Zone contributes to local environmental preservation and improved quality of life by supplying part of its electricity to the neighboring agricultural villages and promoting their electrification.

3.2 Business and Policy Proposals

Referring to the local legislations, environmental and social impact from the project is assessed. Business scheme is also considered including technology specifications, financing, and organizational structure, for necessary measures to establish a feasible JCM project. Land acquirement, permission/license acquirement, measures for improving cost and GHG (greenhouse gas) reduction efficiency, electricity sales, entities to participate in the project (requirements and credibility), and supporting measures through city-to-city cooperation are considered.

3.2.1 Environmental and Social Assessment

Possibilities of environmental impact from PV system with water treatment system utilizing septic tanks and their measures are assessed. Environmental impact assessment. Social impact from construction and land acquisition, along with necessary measures are assessed, referring the local legislations and regulations.

The Myanmar Investment Law was enforced in October 2016. Detailed regulations were announced from February to April one by one. Previously, different investment laws had been applied depending on whether it is foreign investment or domestic investment. The Foreign Investment Law was applied when foreign companies invest in Myanmar, while the Domestic Investment Law when domestic companies do. After the Myanmar Investment Law was enforced in October 2016, however, the new investment law comes to be applied to all companies when they invest in Myanmar. Myanmar Government finished accepting applications of investment based on the former Foreign Investment Law at the end of December 2016, and is accepting applications based on the new Myanmar Investment Law after then.
Difference between foreign capital and domestic capital is still important also in the new Investment Law because restriction on foreign investment still exists. The definition of foreign capital is stipulated to be pursuant to the Company Law. The plan of setting the boundary of the ratio of foreign investment to 35% is now considered under the new Company Law, the revision of which is also discussed now. Under the current Company Law, the foreign capital regulation is applied if foreign investment is included even by one share.
The role of MIC has changed in the new Investment Law. In the former Foreign Investment Law, all projects regulated must receive the permission of MIC. Furthermore, investment incentives including tax exemption and long-term lease of lands were also given automatically with the MIC permission.
In the new Investment Law, the MIC permission is limited to part of projects (Article 36 and 37 of the Law). Tax privilege and the right of long-term lease of lands can be obtained by receiving endorsement separately for all projects other than the regulated ones (Article 37 of the Law). A major revised point is the separation between investment incentives and the approval procedure of projects regulated.

Projects regulated under the new Investment Law are as follows:

Project regulated	Contents, etc.
Projects requiring MIC permission (Article 36 of the Law)	Limited to some important fields including important projects from a viewpoint of national strategy, capital-intensive projects, and projects that exert considerable influence on environment and regional society
Projects prohibited (Article 41 of the Law)	Projects that exert adverse influence on the nation and general public
Projects restricted (Article 42 of the Law)	Projects that can be executed only by the government, projects whose execution by foreign capital is prohibited, projects permitted to joint venture of domestic and foreign capitals only, and projects that need permission of the relevant ministry
Projects requiring the approval of Federal Parliament (Article 46 of the Law)	Projects that exert serious influence on the security of the nation and its citizen, economy, environment and the profit of the nation

<Investment Incentive>

1. Right of long-term lease of real estate
The right that was previously given only to companies having received MIC permission comes to be given to all companies that have complete the approval formalities stipulated under the new Investment Law. Long-term lease becomes permitted not only for lands but buildings by receiving approval.

2. Privilege in taxation
Formalities for approval have to be completed as with the case of long-term lease of real estate. The tax holiday of corporate income taxes is 3, 5 or 7 years depending on the development of the region (it was 5 years across the board under the MIC permission previously). Businesses that can get tax privilege are limited to the ones specified by MIC (Article 75 of the Law).

In order to acquire approvals for foreign investment, project categories identified under the EIAP (Environmental Impact Assessment Procedures) must conduct EIA (Environmental Impact Assessment) or IEE (Initial Environmental Examination), or prepare an EMP (Environmental Management Plan).
EIAP identifies the following categories to conduct IEE or EIA: 1) Project in which investment is decided by the Parliament or the government cabinet or the President, 2) energy sector development, 3) agriculture, livestock and forestry development, 4) manufacturing (food and beverage manufacturing, garments, textiles and leather products, wood manufacturing, chemicals manufacturing, manufacture of glass and ceramics, manufacture of construction materials, metal, machinery and electronics), 5)

waste management, 6) water supply, 7)infrastructure and service development, 8) transportation, and 9) mining.
There is no compulsory environmental standard referenced in EIA. National Environmental Quality (Emission) Guideline was established in 2015 with reference to Environmental Health and Safety Guideline established by IFC (International Finance Corporation), but this standard is only a reference standard. Therefore, currently, EIA must be conducted with regards to international standards (e.g. JICA, IFC, ADB, etc.)

3.2.2 Project Scheme (PV System)

(1) Applied Technology and Specifications

Based on comparisons of possible technologies in candidate project sites, it is concluded that rooftop PV project at factories is the most feasible. Assuming a project size of 1 MW, necessary area for the system would be 10,000 m2.

Table 3-3 Overview of the PV System

Power	1,000	kW
Average Irradiance	19	MJ/m^2/day
	5	kWh/m^2/day
Average annual irradiance	1,928	kWh/m^2*year
Irradiation intensity	1	kW/m^2
Load factor	0.8	
Annual generation	1,542,344	kWh/year
Daily generation	4,226	kWh/day
Necessary area	10	m^2/kW
	10,000	m^2

<Ground mounted systems>
Ground-mounted systems: In this study, ground survey for Myaungmya Industrial Zone is not conducted, so some surveys for foundations would be needed to install PV panels on the ground. They would need to be at least 1.5m higher than the ground with bearing power of 20 kPA, N>60. Additionally, 3 acres (12,140 MW) of land with wind speed less than 32m/sec would be necessary.

<Rooftop systems>
Two cases would be possible as a project in Myaungmya Industrial Zone: to install the system at the renewal of existing jute bag factory building, or to install the system on a new factory.
In the case of installment at the renewal of jute bag factory building, area that can be utilized for the system is approximately 27,000 m2 (120 meters times 225 meters). When assuming that the panels were installed mainly on the south-facing side, panels of 2,000 kW (27,000m2/2*90%/6m2/kW) can be installed. However, the roof would need to be resistant to a weight of 40kg/m2, and reinforcement of the roof would be necessary.

Factories to be built in the future would be of smaller scale, so installing panels would not be efficient. However, there would be more than 120 sections, amounting to 1,200 kW with 10 kW installed on each section.

Most garment factories in Myanmar operate under the Cut-Make-Pack (CMP) System

(2) Financing Scheme

Project investment cost will be planned with respect to SPC investment ratio. Without the base part , the total cost is roughly estimated at 0.26 billion JPY. The cost components are shown below.

Table 3-4 1 MW PV System Cost Estimate (million JPY)

	Estimate
Panel	120
Inverter	33
Installment	69
Others	42
Total	264

Detailed investment amount would need to be considered, but the challenge lies in reducing price for modules (40% of total cost); measures for reducing initial cost , such as procurement of equipment from neighboring countries, would be necessary.

In the new MIC, rights for proceeding with small scale (max. 10 MW) and middle scale (max. 30 MW) projects are given to the municipal government.

However, there are some limitations from the investment amount; the municipal government can only deal with projects under 5 million USD or 60 Kyat (approximately 0.486 billion JPY, 1 Kyat =0.81 JPY). Such regulations limit the possibility for municipal governments to manage renewable energy projects.

If there is no support for investment, such as subsidy, construction cost would be approximately 300,000 JPY/kW; even with low-cost equipment, 1~1.4 MW project scale would be the realistic limitations to renewable energy projects. Such regulations would serve as one hurdle for renewable energy promotion.

(3) Considerations for Project Implementation

PV is categorized under renewable energy, which is a category for investment support. Unlike other renewable energy facilities, there is barely any impact for air, noise, vibrations, water contamination, and land contamination; therefore, in most cases, EIA is not required, and only IEE or EMP are necessary.

However, PV requires a large area of land, which may tighten evaluations for investment permissions. Even if the project site is planned at a fallow land, if the land is categorized as farmland, acquiring residents' agreement and negotiations with related ministry (Ministry of Agriculture, Livestock and Irrigation) would be essential.

(4) Project Organizational Structure

Partner company for supplying and installing PV system will be determined comprehensively from Japanese and non-Japanese companies.

Generally, PV system is easier to maintain compared with other renewable energy sources. However, existing PV systems in Myanmar are mostly small-scale projects, with no experiences in large scale PV projects, and there may be some challenges for companies in Myanmar to maintain the project alone. Therefore, formulation of SPC with Japanese company and local company (e.g. MAPCO) is considered appropriate, for utilizing JCM scheme.

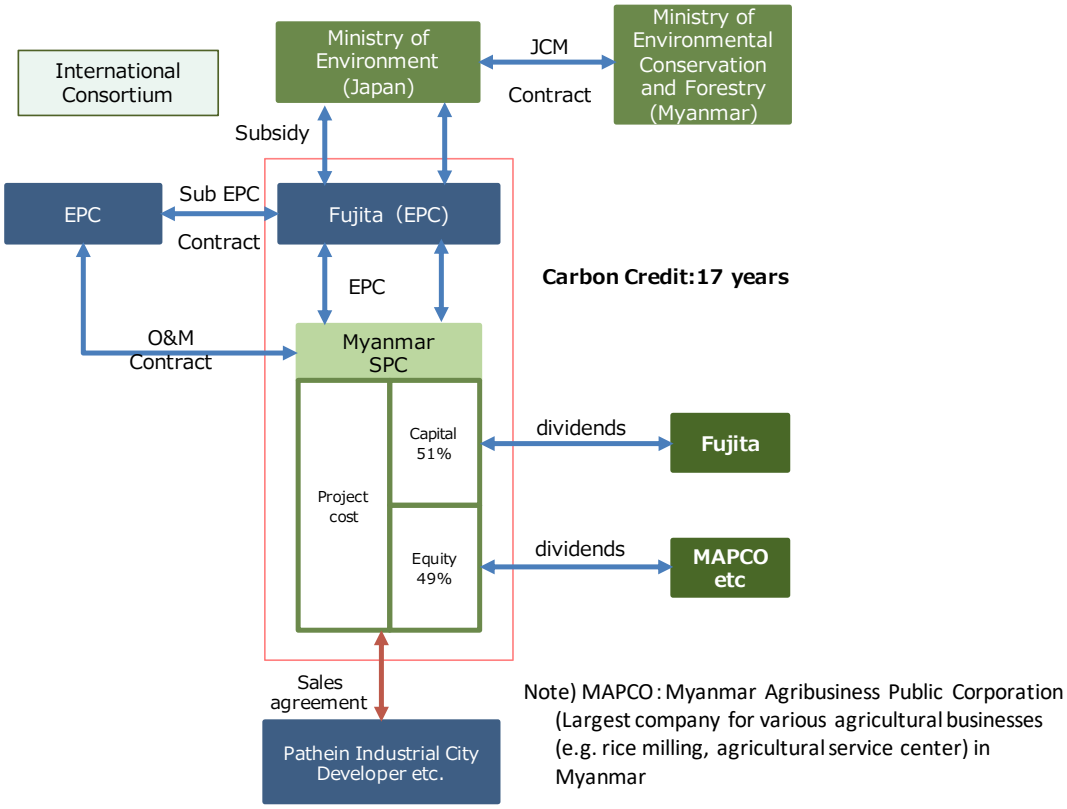

Figure 3-6 Proposed Organizational Structure

(5) Measures for Project Realization

There is no existing MW scale solar projects in Myanmar due to lack of necessary incentives such as FIT, local engineering companies do not have enough knowledge for PV projects, which serves as an unclarity within business feasibility study. Therefore, it is proposed that in prior to construction of 1~2 MW-scale PV projects, the following measures would be taken. The possible two scenarios are shown. In the future, discussions with partner companies will be conducted, including each scenario's pros and cons.

<Option 1>

The total project specifications would be established by the Japanese side, and installations would be contracted to local companies under the guidance of Japanese companies.
<Option 2>
Smaller scale projects (200~300 kW size) would be installed to accumulate experiences and to improve the capacity of local companies.

3.2.3 Project Scheme (Water Treatment Utilizing Septic Tanks

(1) Applied Technology and Specifications

Agricultural product processing factories are being planned in the proposed industrial zone, and a large number of workers will be working in the industrial zone; therefore, installation of waste water treatment facility is indispensable for environmental protection. A single waste water treatment facility can cover the whole 128 sections. However, from the following perspectives, septic tank treatment facility for each area (there are total of 8 areas) would be appropriate: (1) the industrial zone is to be constructed in phases, with changes in plans during the phases, (2) changes in plans would affect waste water pipeline network, and (3) the amount of waste water in each area and its concentration level is different.

(2) Financing Scheme

Project investment cost will be planned with respect to SPC investment ratio. An SPC centered around EPC and operating company would be established, but considering the features of septic tanks and the necessity for transferring technology and operational know-how, investment ratio can be determined in each village or township that would receive benefits of septic tanks.

(3) Project Organizational Structure

Partner company for supplying and installing septic tanks will be determined comprehensively from Japanese and non-Japanese companies. Japanese companies are willing to engage in maintenance and operation, as well as installation, which would be beneficial for Myanmar, in which engineers for such treatment systems are underdeveloped.

(4) Measures for Environmental Regulations

There are no particular legislations regarding septic tanks. Building permits evaluates whether there is necessary facility for waste water treatment. Such standards are applied for new buildings, but there are no standards that apply to waste water treatment systems in existing villages. When applications for permits are provided, it is expected that the evaluation will be conducted with respect to various existing legislations.

(5) Measures for Project Development

Foreign companies have installed water treatment facilities utilizing septic tanks in the past, but they have not been well operated due to lack of guidance and capacity for local engineers for operation and maintenance. Myanmar does not have high consciousness for operation and maintenance. Septic tanks have the benefits of low investment cost and short construction time. However, they are planned with the assumption that operation and maintenance will appropriately be conducted; without appropriate maintenance, they cannot keep their functions. Operation and maintenance structure can be established at the proposed project site, an industrial zone, and it can also serve as a model for waste water treatment utilizing septic tanks for the surrounding agricultural villages.

It is assumed that several systems would be implemented in Myaungmya Industrial Zone as a start, but they can be deployed horizontally to other areas as well.

3.3 Examination of GHG Emission Reduction

3.3.1 Identify Baseline Emission Factor

Power supply destination of this project is the demand of industrial park, and the connection to the national grid does not assume at present. On the other hand, there has not published grid emission factor in Myanmar in this current situation. It is important to identify the alternative for energy (power) generation. In a recent CDM methodology, "Isolated Grid System" concept has been added. This concept is not limited to small scale project and has been studied the effect of introducing renewable energy in a wide range of micro-grid and off-grid . In this project, an appropriate baseline emission factor was verified to the reference to the existing CDM and JCM methodology.

(1) CDM Project in Myanmar

Power supply destination of this project is the demand of industrial park, and the connection to the national grid does not assume at present. On the other hand, there has not published grid emission factor in Myanmar in this current situation. It is important to identify the alternative for energy (power) generation. In a recent CDM methodology, "Isolated Grid System" concept has been added. This concept is not limited to small scale project and has been studied the effect of introducing renewable energy in a wide range of micro-grid and off-grid . In this project, an appropriate baseline emission factor was verified to the reference to the existing CDM and JCM methodology.

(2) The Latest Trends in the CDM: Isolated Grid System

CDM Methodology, "Tool to calculate the emission factor for an electricity system " , has been revised to Version 7 on November 1st , 2017, the new concept of "small isolated grids in SIDS and LDC" has been added. “Small isolated grid” is an electricity system supplying electricity to household users, and if applicable, industries and commercial areas that is not connected to any other electrical network (e.g. national/regional or interconnected power system) and meet one of the following conditions:

- Any grid located in a Least Developed Country (LDC) or small island development State (SIDS) where at least 65 per cent of the power installed capacity is based on fossil fuel sources - solid, liquid or gaseous;
- Any grid where 65 per cent of the power installed capacity is based on liquid fossil fuel sources;
- Any grid with a maximum power installed capacity of 1,000 MW and at least 80 per cent of the power installed capacity is based on fossil fuel sources - solid, liquid or gaseous;

In this methodology, it is classified into two types, “isolated grid system with a single diesel/fuel oil generator power plant” or “isolated grid system with multiple power

plants". The following three patterns are shown for the calculation method in " isolated grid system with multiple power plants" targeted by this project.

- Isolated grid system with only liquid fuel power plant
- Isolated gird systems with multiple fuel and technology types without combined cycle power plants
- Isolated grid systems with multiple fuel and technology types with combined cycle power plants

As described above, when the method was applied to this project is selected, "isolated gird systems with multiple fuel and technology types without combined cycle power plants", the calculation method is as follows.

- It follows the calculation formula a), weighted average emission factor calculated using the procedure contained in appendix 4, "Equation for calculating weighted average emission factor for an isolated grid"
  - Calculation formula a): The weighted average of the open cycle power plant 0.47t-CO2 / MWh of using strains emission factor and gaseous fuels by the calculation formula b)
  - Calculation formula b): "AverageCM = w1 × OM + w2 × BM" is calculated as OM: 0.79t-CO2/MWh and BM:0.58t-CO2/MWh.
  - Wind and solar power generation project activities: w1 = 0.75 , w2 = 0.25
- If there is no use of gaseous fuels, 0.40t-CO2 / MWh, and others are 0.32t-CO2/MWh.

Selecting the former approach, the grid emission factor (Average Combined Margin) is calculated as 0.7375 t-CO2 / MWh since the power plant using the gas fuel does not exist.

(3) CDM Small Scale Methodology: AMS-IF

Small-scale methodology for the renewable energy introduction on the assumption of less than 15MW "AMS-IF: Renewable electricity generation for captive use and mini-grid " has been revised in November 2014, the grid emission factor in the base line to be set as shown in the table.

Table 3-5 Emission Factors for Diesel Generator Systems (in kg CO2/kWh) for Three Different Levels of Load Factors

Cases	Mini-grid with 24 hour service	(a) Mini-grid with temporary service (4-6 hr/day); (b) Productive applications; (c) Water pumps	Mini-grid with storage
Load factors [%]	25%	50%	100%
Less than 15 kW	2.4	1.4	1.2
15 kW or more and less than 35 kW	1.9	1.3	1.1

35 kW or more and less than 135 kW	1.3	1.0	1.0
135 kW or more and less than 200 kW	0.9	0.8	0.8
200 kW or more	0.8	0.8	0.8

Source) CDM Small Scale Methodology AMS-IF

In this project, a mini-grid provides a 24-hour power service, and the load is assumed over 200 kW. Therefore, the grid emission factor is selected as 0.8t-CO2 / MWh.

(4) JCM Methodology

The format of the JCM methodology of solar power generation is attached as additional information for calculation method conservative emission factor. The two types are envisaged, the national grid is covered in the whole country such as Vietnam and Costa Rica and some regional grids are covered in each region such as Chile[2], the following will organize its concept.

Currently JCM methodology, as conservative method of calculating the grid emission factor, the methodology of the following two kinds of patterns have been approved. Concept of grid emission factor for each pattern, Case1: national grid and the weighted average of all power plants connected to the local system, Case3: the emission factor of diesel generators in the world maximum efficiency 49%[3] , Case 2 is conservatively set with lower values of Case 1 and Case 3 .

Table 3-6 Proposal (introduction) Case Classification at the Destination Power Plant

Country	Case 1	Case 2	Case 3
Vietnam / Costa Rica etc.	Project is connected to the national grid including through internal grid which is not connected to a captive power generator	Project is connected to internal grid which is connected to both the national grid and a captive power generator	Project is connected to an internal grid which is not connected to the national grid. (Do not connected to the national grid)
Chile etc.	Project is directly connected to a regional grid, or connected to a regional grid via an internal grid not connecting to a	Project is connected to an internal grid connecting to both a regional grid and a captive power generator	Project is only connected to an internal grid connecting to a captive power generator (Do not

[2] However, system connection through the direct current power transmission between SING and SIC grid in Chile was approved by Congress in 2015 and connection will be started from 2018 expected

[3] Using the diesel fuel emission factor 72,600kgCO2 / TJ based on IPCC 2006 Guidelines, calculated to 0.533t-CO2 / MWh.

	captive power generator		connect to regional grid)

Source) MRI created on the basis of JCM methodology Solar Power Generation, “Additional information on calculating the conservative emission factor” in Vietnam, Costa Rica, Chile

(5) Setting Baseline Emission Factor to be Adopted in this Project

In this project, to form a micro-grid in the industrial park, and performs power supply from the solar power plant. Therefore, there is nothing to be applied to existing JCM methodology, it is necessary to set a new baseline emission factors. Although it is desirable to set the grid emission factor of CDM reference, the concept can currently use two types exist. The concept of Isolated grid system is the latest of the discussion result, it has been re-built settlement of the existing problems, but the thing is highly relevant, intended to be set by a number of options, and the slightly more complex ones . Therefore, in this project, selecting the emission factor for diesel power generation system according to the load level being presented by CDM small methodology AMS-IF.

3.3.2 Estimated Results of Emission Reduction

Based on the aforementioned points, the amount of emission reduction was estimated as follows:

Table 3-7 Estimated Results of Reduction Amount (PV System)

PV System		
Installed Capacity	2,000	kW
Annual generation	3,084	MWh/year
Grid emission factor	0.8	t-CO2/MWh・CDM Methodology AMS-I.A
Estimated reduction	2,468	t-CO2/year

3.4 Support for Planning and Capacity Building

(1) Support for Policy Development

Through the Fukushima City workshop held in July inviting local government officers, activities for PV system promotion and regulations for water quality conservation (particularly on-site investigation which were of high interest by the local officers) were introduced.

- Overview of workshop and site visits in Fukushima City
  From July 24th (Mon) to July 26th (Wed), two officers from Ayeyarwady Region were invited to Fukushima City, and courtesy visit to the mayor, Local site visits and workshops were held.
  Measures for promoting PV systems and regulations for water quality conservation in Fukushima City (particularly on-site investigation which was of high interest by the local officers) were introduced. Additionally environmental education program in school (elementary school) was introduced; teachers from the local elementary school participated in lectures and explained about the program, and a video letter from the students was provided. Through the workshop and site visits, the content of various activities was understood by the Ayeyarwady Region officers, and they commented that the activities were very helpful as a reference for considering future activities in Ayeyarwady Region as well/

In the local workshop (held in February in Yangon, renewable energy promotion policies in Fukushima City were introduced, and discussions for low-carbon waste treatment system (rice husks) and energy policies that may be related to PV system installation in Myanmar were held. Myanmar is in shortage of power supply, but additional electricity would need to utilize environmentally friendly renewable energy, and it was agreed that specific measures would be considered with the public and private sector under the city-to-city collaboration.
The following policies in Fukushima City were introduced:

- Fukushima City Renewable Energy Promotion Plan
- Future Visions of Fukushima City
- Arakawa Clean Center (Local generation and consumption of waste power plant)
- Deployment of Renewable Energy Power Plant
- PV System Installment Subsidy
- Programs for Interest Subsidy for Renewable Energy Related Facilities

Additionally, there was a courtesy visit for the Ministry of Agriculture, Livestock and Irrigation of the Union of Myanmar. The activities in Ayeyarwady Region and Sagaing Region under city-to-city cooperation, along with features of Fukushima City (tourism, agriculture, processed products such as bread utilizing rice flour and Japanese sake) were introduced. The Minister showed appreciation towards the past support by Fukushima City, and expressed his intent to provide further support for low-carbon waste treatment system (rice husk power plant).
Through the workshop, a shared understanding for the importance of utilizing

renewable energy in industrial zones and rice mills development was formed. The understanding was shared not only with the government officials, but also with the union officials such as the Minister for the Ministry of Agriculture, Livestock and Irrigation of the Union of Myanmar (power supply with renewable energy for development of rice mill industry).

- Overview of Joint City-to-City Collaboration Workshop with Ayeyarwady Region and Sagaing Region

Date	February 6th (Tue) 15:00~17:00
Venue	Meeting Room in Yangon
Participants (28 in total)	・Japanese side: 10 participants (including: Fukushima City officers, Fukushima Chamber of Commerce and Industry board directors, Mitsubishi Research Institute, Fujita Corporation (including Yangon Branch staffs, etc.) ・Myanmar Side: 18 participants (including: Engineers from Sagaing Region and Ayeyarwady Region, officers from Yangon, Myanmar Rice Federation, MAPCO, etc.)
Overview	・Renewable energy promotion plan in Fukushima City was introduced, and energy policies related to PV system installation and low-carbon waste treatment system (rice husk power plant) in Myanmar were discussed. ・Myanmar is in shortage of power supply, but additional electricity would need to utilize environmentally friendly renewable energy, and it was agreed that specific measures would be considered with the public and private sector under the city-to-city collaboration.

- Overview of Courtesy Visit to the Minister of Agriculture, Livestock and Irrigation

Date	February 7th (Wed) 13:30~14:00
Venue	The Republic of the Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI) Meeting Room
Participants (15 in total)	・Japanese side: 10 participants (including: Fukushima City officers, Fukushima Chamber of Commerce and Industry board directors, Mitsubishi Research Institute, Fujita Corporation (including Yangon Branch Staffs)) ・Myanmar side: 5 participants (including Minister of Agriculture, Livestock and Irrigation, UMFCCI, Myanmar Rice Federation)
Overview	・There was a courtesy visit to the Minister of Agriculture, Livestock and Irrigation, and the activities in Ayeyarwady Region and Sagaing Region under city-to-city cooperation, along with features of Fukushima City (tourism, agriculture, processed products such as bread utilizing rice flour and Japanese sake) were introduced. ・The Minister showed appreciation towards the past support by Fukushima City, and expressed his intent to provide further support for low-carbon waste treatment system (rice husk power plant).

(2) Environmental Education

Environmental program in elementary school was introduced (a teacher from the local Fukushima City elementary school participated and also shared a video letter from the students). Through the workshop and local site visits, the content was explained, and the Ayeyarwady Region officers commented that it was very insightful for future activities in Ayeyarwady Region.

(3) Business Interactions

On invitation to Fukushima City in July, there was a networking event with the member companies of Fukushima Chamber of Commerce and Industry. The officers shared current situation and trends in investment law and discussed about the possibility for Fukushima companies to do business in Myanmar.

During the networking event in February in Yangon with the local business stakeholders, companies from Fukushima were introduced, including those engaged in waste paper recycling, biogas power plant from waste water, unique products for environmental conservation and industry promotion, and MW-scale solar power plants (there are several MW-scale solar power plants in Fukushima City utilizing idle land). Discussions were held on the possibility for collaboration between Myanmar companies and Fukushima City companies; a shared understanding was formed that business dialogues are important for specific collaborations. To achieve low-carbon society, project formulation in the business sector, along with policy development, is important. The related stakeholders recognized such low-carbon society concept as a business opportunity as well (through the shared experiences of Fukushima City companies). This was the first attempt to conduct business-side dialogue between the local chamber of commerce, and it was understood that there were high expectations for Japanese government, and continued interaction would be important (e.g. specific collaborations with MAPCO; MAPCO is a large company engaged in agricultural businesses in Myanmar).

- Overview of Discussions with Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI) and other Business Stakeholders

Date	February 7th (Thu) 14:00~16:00
Venue	Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI) Meeting Room
Content	・During the networking event, activities of Fukushima City were shared from the Chamber of Commerce and Industry, and discussion was held on possibility for collaboration between Myanmar local companies and Fukushima City companies. The importance of business dialogue for establishing specific plans was understood among the participants.
Participants (26 in total)	・Japan side: 10 participants (Fukushima Chamber of Commerce and Industry, local companies, Fukushima City officials, Mitsubishi

	Research Institute, Fujita Corporation) ・Myanmar side: 16 participants (Union of Myanmar Federation of Chambers of Commerce and Industry, Myanmar Rice Federation, MAPCO, local companies)

(4) Capacity Building (Measurement of Solar Radiation)

A solar radiation meter was installed on the roof of Pathein Industrial City. A student from Pathein Technological University collected its data and organized the data. With no past experiences in such measurement, there were some troubles in the beginning, but an accurate measurement and data analysis was able to be conducted in the later phase.

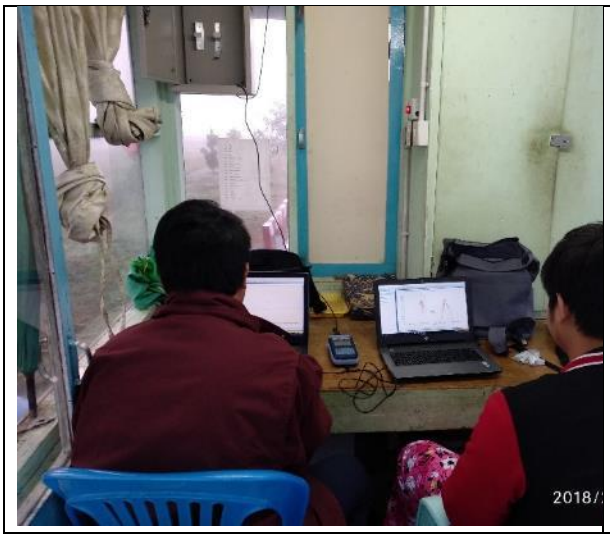

Figure 3-7 Solar Radiation Measurement Capacity Building

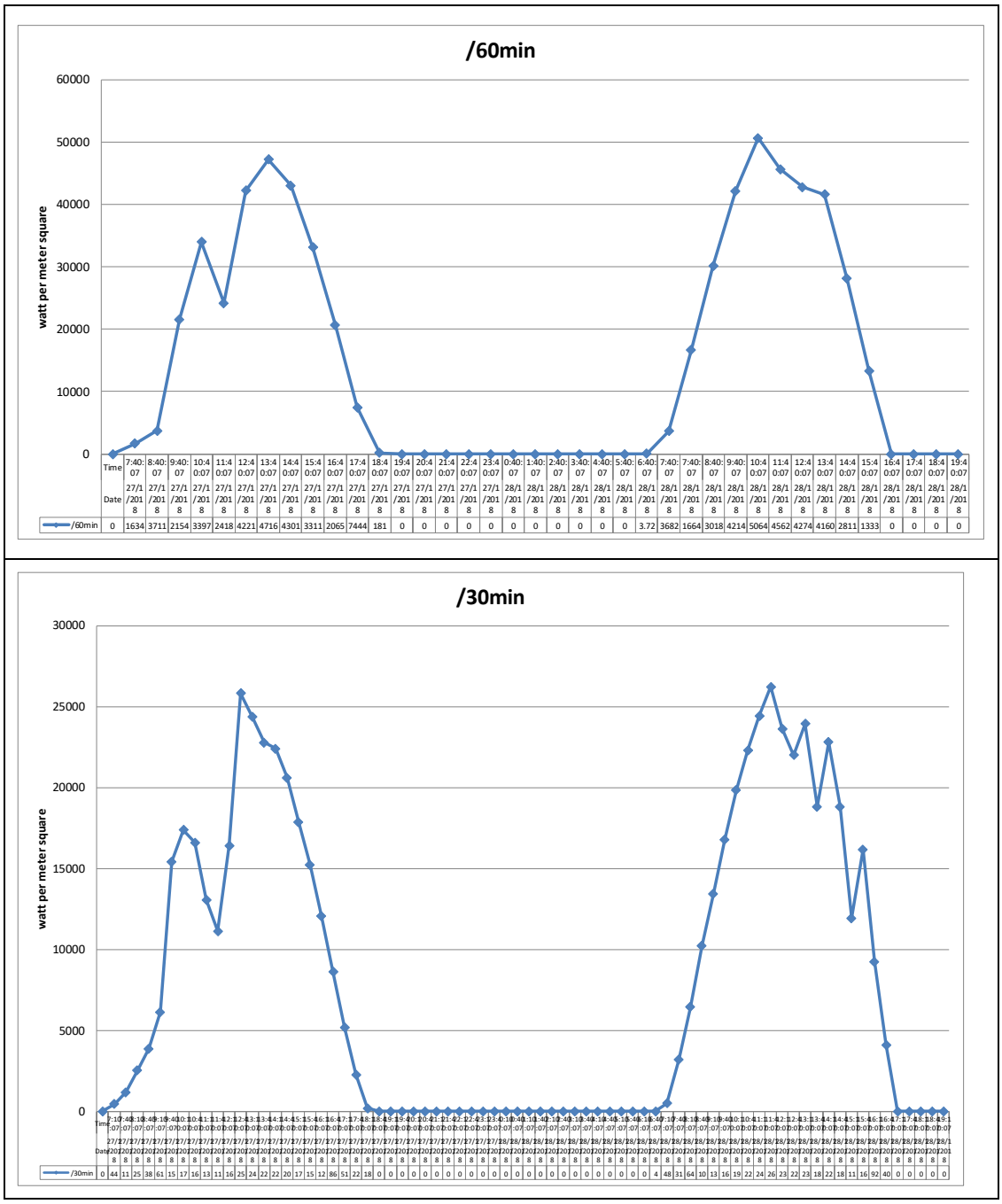

Figure 3-8 Measurement Data for Solar Radiation

4. Future Project Development

Based on this year's survey results, plans for future project development were considered.

(1) PV Systems in Industrial Zones

- Myanmar has only installed small scale solar panels and has not installed any large scale solar systems. A deeper understanding for such systems and intent for such project formulation at the regional level was established after introducing policies, and MW-scale solar power plant promotion facilities in Fukushima City and acquiring a realistic image of such power plant generation and facility.
- However, there are no large scale PV project experiences in Myanmar and there are high risks for such projects. An effective approach under such situation would be to install multiple smaller scale projects (200~300 kW scale factory rooftop installed systems) to accumulate experiences and increase the capacity of local companies.
- Additionally, as electricity prices in Myanmar are low, negotiations would be needed through policy dialogues with the regional government to set a better pricing standard for renewable energy projects, from the aspect of local energy policy and regional development.

Item	Key activities	Outcome and future tasks
JCM Project Formulation	Examination of candidate sites Examination of installation costs	●There are no experiences in large-scale PV projects and risk is high. ●Possibility for a rooftop solar project at an industrial city needs to be considered first. ●Pros and Cons of following two options are explored <Option 1> Japan side determines all specifications including installation work and consign the installation under Japanese company's supervision to local companies. <Option 2> Raise the potential of local companies through the implementation of small-scale installation (several hundred-kW level).

(2) Policy Development through Policy Dialogue

<Water Treatment and Water Quality Management>

- In Myanmar, although legal systems for environmental regulations have been

developed, challenge is how to implement them. They deepened the understanding of the mechanism including spot inspection at municipality level, and sampling/analysis of wastewater (outcome of capacity building specific to intercity cooperation between municipalities).

- Challenge is how to share what the invited officers learned among other relevant parties in the region. It is also important to implement activities in Myanmar based on the activities in Japan.
- Water treatment is an important issue (shared understanding with the regional officials) for rapid economic development; discussions for integrated regional development with industrial zones are essential.

<Low-carbonization of industrial zones>
~Possibility for Low-Carbon Urban Development Model as Agricultural Industrial Zone and Agricultural Industrial City~

- Construction of Myaungmya Industrial Zone (agriculture and food related) is proceeding with support from the government (regional and union). Rice husk power plant of 1.6 MW is proceeding as well with JCM subsidy, and receives high expectations from the government (the responsible minister is satisfied as well).
- Through policy dialogues, the responsible counterpart minister are those responsible for electricity, energy, industry and transport. They have high interest for low-carbon, environmentally friendly industrial zone development (including its surrounding areas) from multiple aspects of energy access (renewable energy, distributed energy resources), environmental conservation, and local industry promotion. In the future, specific measures would need to be planned under city-to-city collaboration.

Item	Key activities	Outcome and future tasks
Policy dialogue, etc.	Relationship management with the responsible minister of energy Through the workshop in the region, common understanding was obtained of the importance of using renewable energy for restructuring of industrial complexes and rice mills.	● Share recognition on expansion (i.e., securing of electricity by renewable energy is an effective approach to the development of rice milling business) with not only the chief executive and the responsible minister of the region but other relevant parties including Ministry of Agriculture, Livestock and Irrigation of the Union of Myanmar. ● Hereafter, conduct policy dialogue to embody the low-carbon society concept in the developing Myaungmya Industrial Complex (The responsible minister of the region is interested in promotion of local electrification using renewable energy. The

		direction required is shared, and now is the stage to deepen concrete policy).

Low-carbon regional development model as an agricultural industrial zone or an agricultural town can be developed horizontally in the future (there will be discussions with the Regional Chief Minister and MAPCO to formulate specific measures). Such discussions will not be limited to PV systems but will try to draw the whole picture of low-carbon industrial zone and regional development.

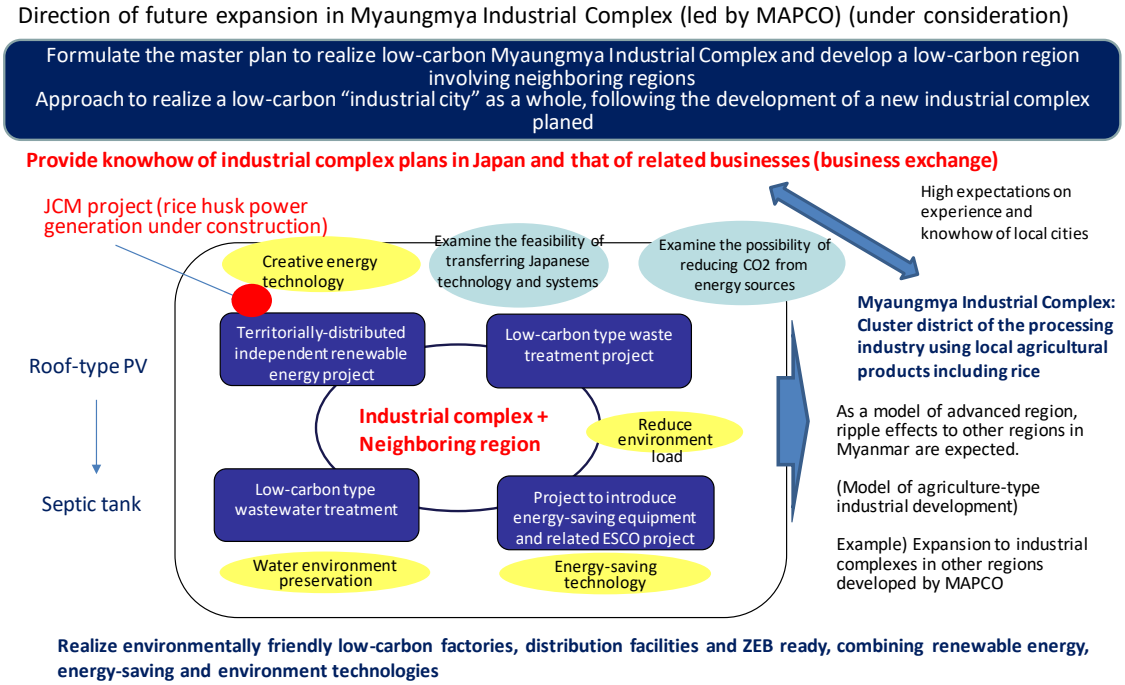

Figure 4-1 Future Development Plans at Myaungmya Industrial Zone

(3) Capacity Building

<Environmental Education>

- Deeper understanding for importance of environmental education was achieved, and the region now would like to implement such concept in environmental education. It is expected that efforts in school bring about the awareness-raising of parents (They recognize that awareness of adults on environment preservation is low and awareness-raising is necessary).
- Environmental education is an approach that can be implemented easily by the municipal government; continuing such educational program is important.

<Business interactions>

- In the future, dialogue between businesses, including Fukushima Chamber of Commerce and Industry, member companies, local Chamber of Commerce and Industry and members would be necessary for possibility of collaboration on specific projects.

Item	Key activities	Outcome and future tasks
Business exchange and capacity building	Through the workshop in the region, ● Activities of companies in Fukushima City (Mega Solar, environment, etc.) were introduced to relevant business parties there. ● Opinions were exchanged on the possibility of cooperation between companies in Myanmar and Fukushima City. ● Importance of dialogue to embody businesses was confirmed and recognition was shared.	● It was understood that not only policy formation but project creation in the business sector has an important role to realize a low-carbon society. ● It was agreed that companies should understand that this is a business opportunity (which is learned through the examples of companies in Fukushima City) ● Dialogue with Chamber of Commerce and companies in Myanmar was a new attempt. They have high expectations on Japanese companies. We share recognition that continued exchange triggered this dialogue is important (example: realize cooperation with MAPCO, one of the foremost agriculture-related enterprise in Myanmar. Cooperation with companies in Fukushima is expected).